QMINERAL

analysis & consulting

Qmineral is an independent materials test laboratory,
providing third-party analytical services to a large range of worldwide industrial partners.

When you need accurate data, not just data.

Q MINERAL
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Nr 1 commercial lab in the world for accurate material testing, being best equipped for fast, high quality analysis results

What's in it for you?

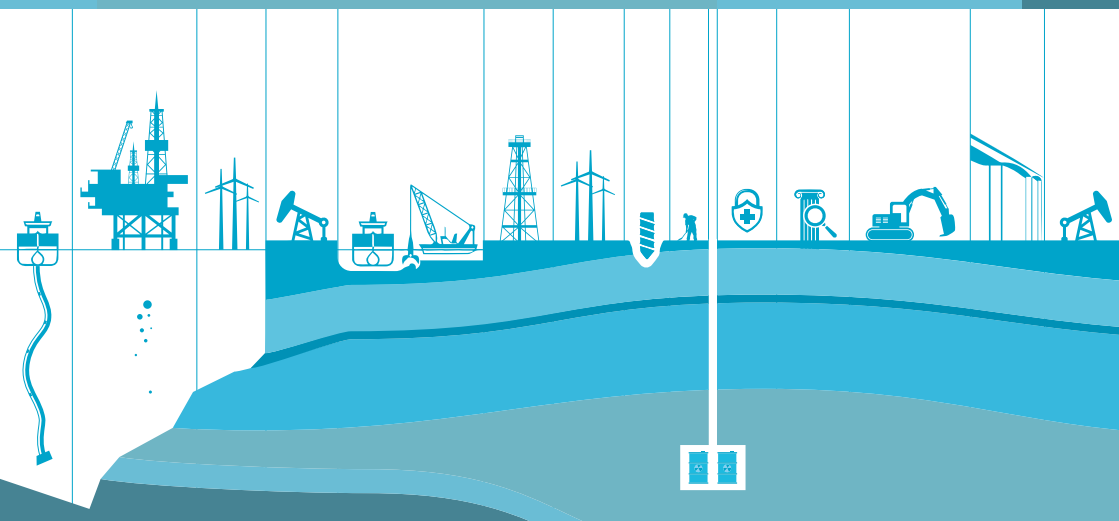
Unique sample preparation resulting in accurate, quantitative data

Unique data processing for the most reliable and most accurate results

Better use our services in early stage (quality control) instead of later (damage claims) …

Only commercial lab in the world able to identify, quantify and characterize (clay) minerals to species level (including degree of mixed layering, Fe-contents of minerals, average crystallite thicknesses, etc.)

Our expertise and knowhow provide a solid base for a successful start of your project



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supports various industries

INDUSTRY	MAIN ACTIVITY
Oil & Gas	(1) Quantitative mineralogy, (2) Detailed clay analysis, (3) Cation Exchange Capacity (CEC), (4) Total Organic Carbon (TOC)
Geotechnics	(1) Mineralogy, (2) Analysis of Particle Size Distribution (PSD), (3) Glauconite content, (4) Microscopy
Industry-processing	Quantitative mineralogy
Health & Safety	(1) Measurement of all physical and chemical agents – Respirable silica, heavy minerals, VOC's, etc.
Dredging	(1) Quantitative mineralogy, (2) Detailed clay analysis, (3) Analysis of Particle Size Distribution
Primary raw materials	Quantitative mineralogy
Technical advice / consultancy	Various analysis
Secondary raw materials	Quantitative mineralogy
Restoration	Optical and scanning electron microscopy
Education/Training	Software packages (via Instrument production company)
Research	(1) Quantitative mineralogy, (2) Detailed clay analysis, (3) Various techniques


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MINERALOGY – XRD

X-ray diffraction (XRD): bulk sample mineralogy

XRD is the ideal tool for basic mineralogical characterization of source rocks, reservoirs and seals. Although XRD is considered a routine analysis, the results are strongly dependent on the skills of the operator. The robustness of Qmineral's mineral quantification procedure was rewarded by a 1st place in the 8th Reynolds Cup (edition 2016 – aka "the world championship of quantitative mineralogy"). For Quantitative Phase Analysis (QPA), both sample preparation and data processing are crucial. The systematic approach taken by Qmineral guarantees excellent reproducibility and accuracy. Bulk samples are finely ground in a liquid slurry and spray-dried. For the data processing of the bulk analyses, we combine the advantages of both the profile summation and the Rietveld method.

Analysis	Required sample size	Turnaround time*
Quantitative mineralogy by XRD – bulk sample analysis	4 grams	1 week

(*) rush analysis possible on demand

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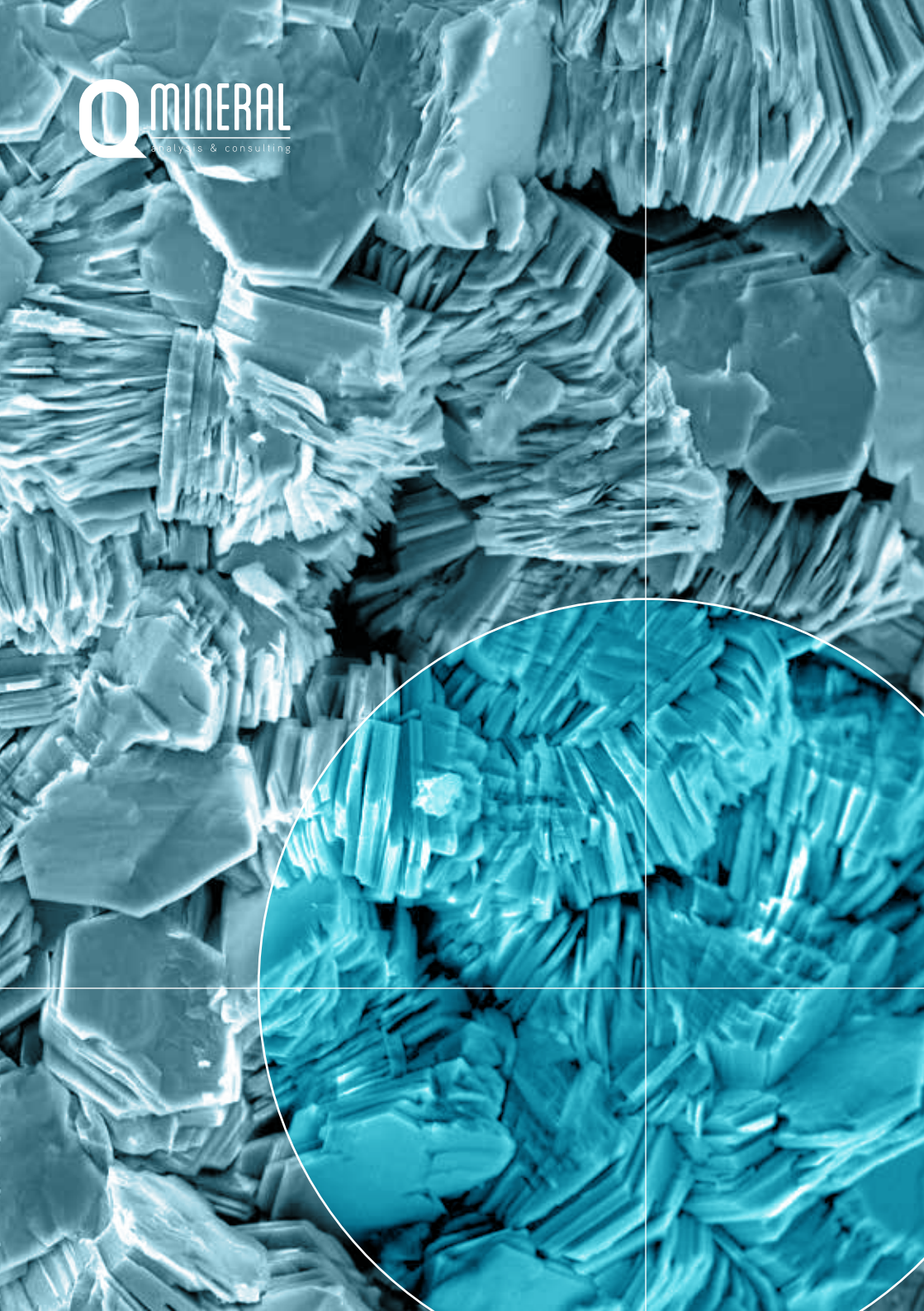
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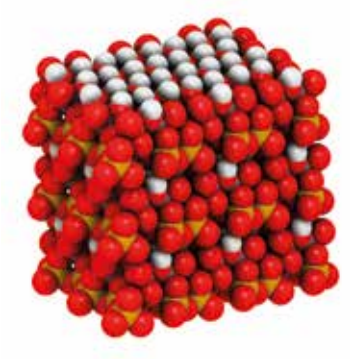
MINERALOGY – XRD

(DETAILED CLAY ANALYSIS)

X-ray diffraction (XRD): detailed clay mineralogy

For the detailed study of clay minerals, Qmineral uses a thorough preparation to remove cementing agents and to extract the size fraction of interest. Oriented slides of these clay-enriched fractions are measured by X-ray diffraction. The subsequent quantification of the clay fraction is done by modelling of the X-ray diffraction patterns.
Not only quantitative information is provided, but also detailed information on the types of minerals present, the degree of mixed-layering, the expandability, the amount of Fe in in the crystal structure, the average crystallite thickness, and of course the quantitative clay content. Accurate densities can be calculated from these mineralogical data.



Analysis	Required sample size	Turnaround time
Quantitative mineralogy by XRD – bulk sample analyses + detailed clay analysis	Clay rich: 10g Clay poor: 25g	3 weeks

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TEXTURE ANALYSIS

Quantitative High-Resolution X-ray Texture Goniometry (HRXTG)

The orientation of clay minerals in rocks can be measured by X-ray diffraction in transmission mode (see Day-Stirrat et al., 2008). Information about the microfabric of the clay-bearing rocks allows to understand changes in porosity, pore throats, etc.
For example: calcite-cemented lithologies in the Barnett Shale may be of interest from an exploration perspective as primary sediment characteristics may be preserved which have been lost through compaction, dissolution, or replacement in non-cemented equivalents. These textural features can be assessed from HRXTG measurements.

Day-Stirrat, R., Aplin, A., Srodon, J., van der Pluijm, B. (2008). Diagenetic Reorientation of Phyllosilicate Minerals in Paleogene Mudstones of the Podhale Basin, Southern Poland. Clays and Clay Minerals 56, number 1, pp. 100-111.

Analysis	Required sample size	Turnaround time
HRXTG-texture analysis	Slice of approx. 1cm x 1cm x 0.1cm (0.4 inch x 0.4 inch x 0.04inch)	2 weeks

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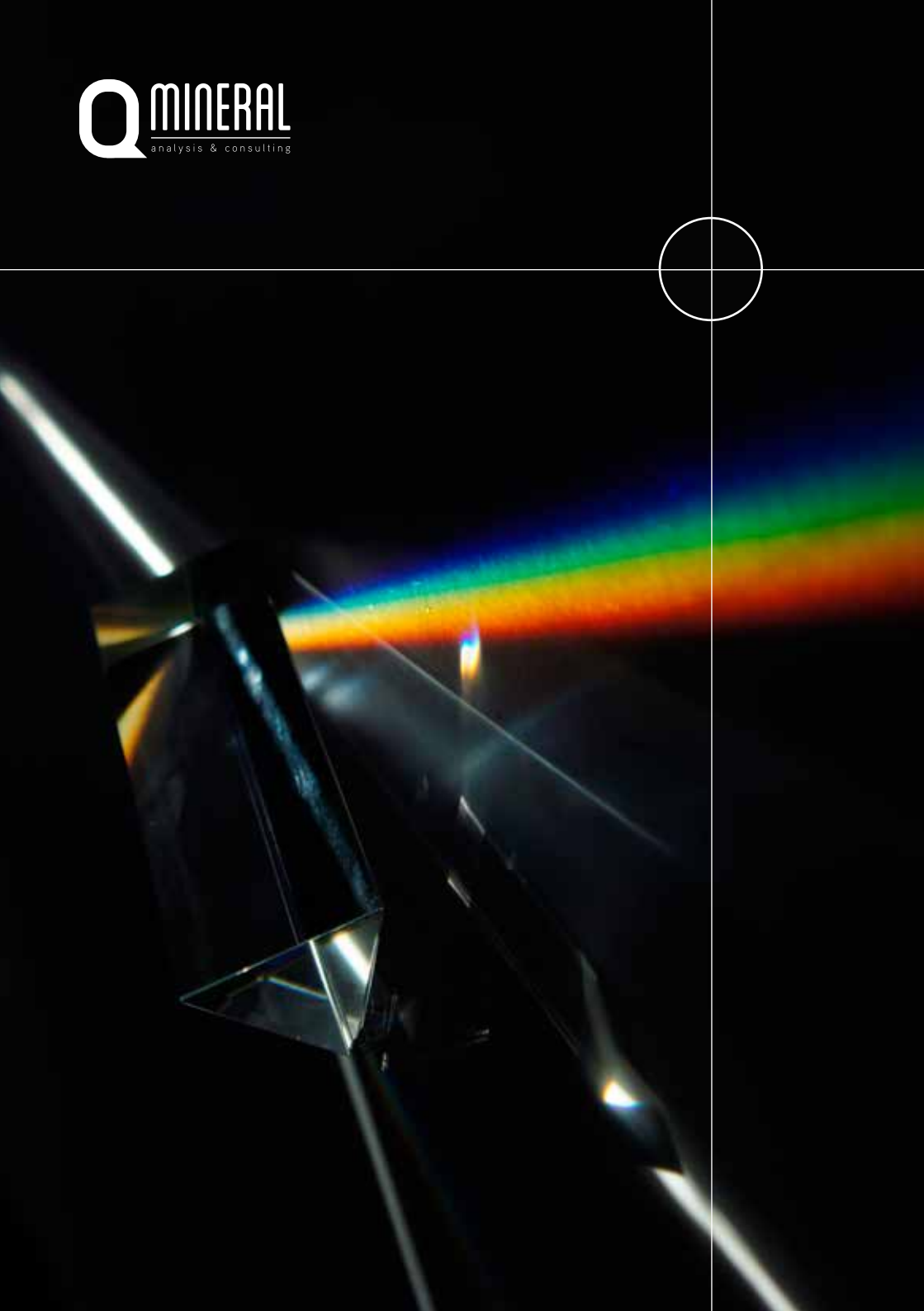
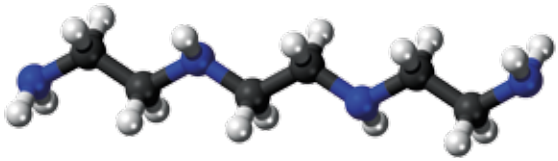


CEC

Cation Exchange Capacity (CEC)

The Cation Exchange Capacity (CEC) is an accurate indicator of the swelling capacity of a rock sample. It has been shown to relate to several mechanical properties and is a good index property to assess formation damage potential. In addition, CEC is an essential parameter in the evaluation of log data, because cation exchange sites contribute substantially to the electrical properties of a formation. Our analysis protocol is based on the exchange of the sample with Cu-triethylenetetramine ("Cu-trien") and the subsequent spectrophotometric analysis of the exchanged liquid (see Meier & Kahr, 1999 and Stanjek & Künkel, 2016). To avoid influences of changing pH due to sample specific properties, all measurements are pH-corrected.



Meier L. & Kahr G. (1999). Determination of the cation exchange capacity (CEC) of clay minerals using the complexes of copper(II) ion with triethylenetetramine and tetraethylenepentamine. Clays and Clay Minerals, 47, 386–388.
Stanjek, H. & Künkel, D. (2016). CEC determination with Cu-triethylenetetramine: recommendations for improving reproducibility and accuracy. Clay Minerals, 51, 1-17.

Analysis	Required sample size	Turnaround time*
Cation Exchange Capacity (CEC)	0.5 grams	2 days

(*) rush analysis possible on demand

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CHEMISTRY – XRF

X-ray fluorescence (XRF)

X-ray fluorescence is used to determine the inorganic elemental geochemical composition of samples. Homogeneous samples are prepared by fusion in Li-metaborate/tetraborate or by dissolution in boric acid. The subsequent wavelength dispersive measurement allows the quantification of major and trace elements in rocks, minerals, and sediment.

Analysis	Required sample size	Turnaround time*
Chemistry by X-ray Fluorescence (XRF)	4 grams	1 week

(*) rush analysis possible on demand

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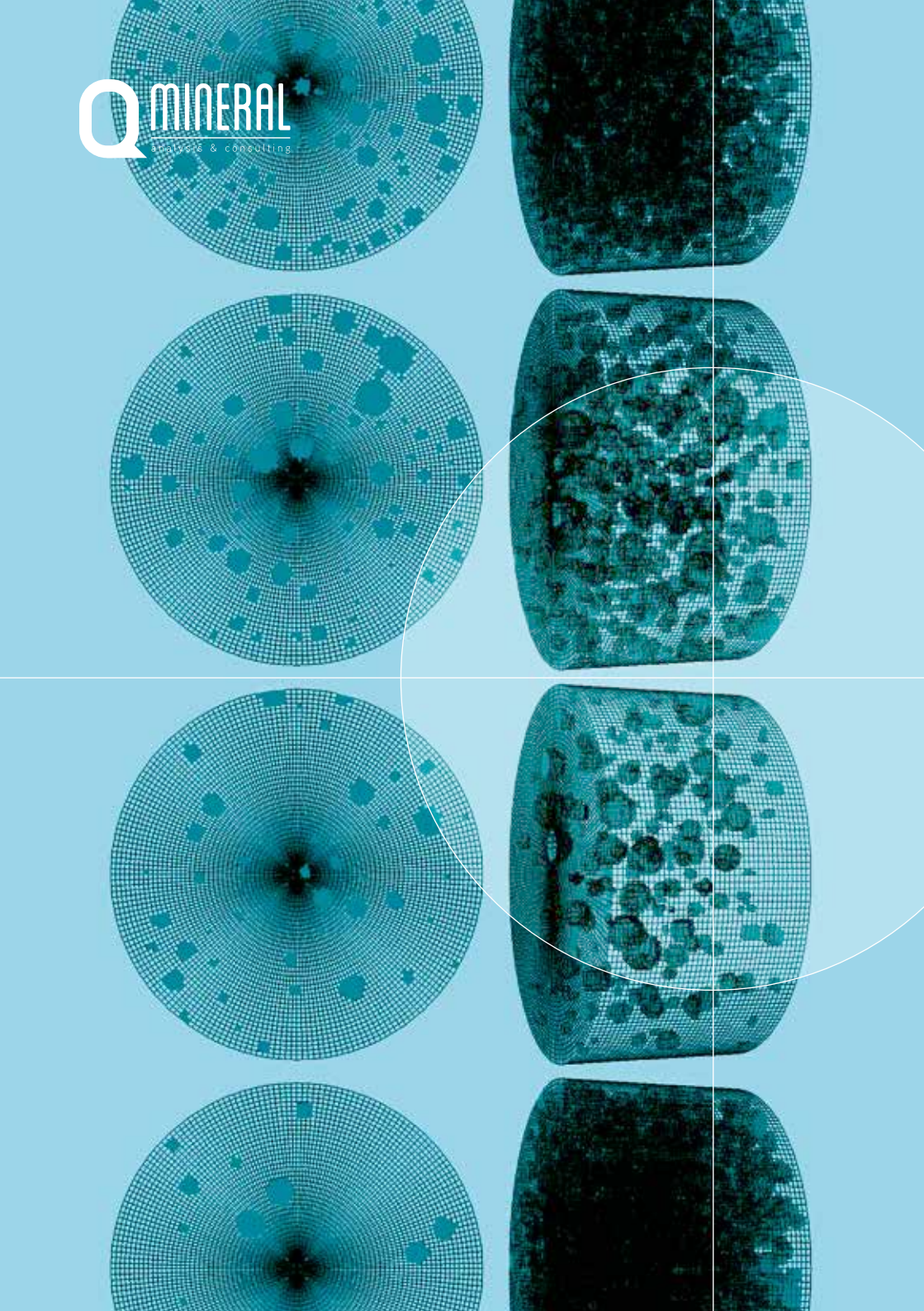
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Grain-density

He-pycnometry

The average grain-density of a sample can be calculated from its mineralogy and TOC content, or measured directly by He-pycnometry. Known quantities of helium gas are expanded into a cell containing the sample, at different pressures but constant temperature. A gas law (corrected for non-ideality) is used to calculate the skeletal volume of the sample, from which the grain density is obtained, using the sample mass.

Analysis	Required sample size	Turnaround time*
Grain-density by He-pycnometry	4 grams	1 week

(*) rush analysis possible on demand

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TOC

Total Organic Carbon (TOC)

The amount of organic carbon present in a rock is a determinant factor in a rock's ability to generate hydro-carbons. Hence, Total Organic Content (TOC) is a key parameter in the evaluation of source rocks and shale reservoirs. It is determined from an open-system pyrolysis in which the produced amount of CO_2 is measured (LECO method). Additionally, the same analysis gives an indication of the inorganic carbon content (TIC).

Analysis	Required sample size	Turnaround time*
Total Organic Carbon (TOC)	0,5 grams	1 week

(*) rush analysis possible on demand

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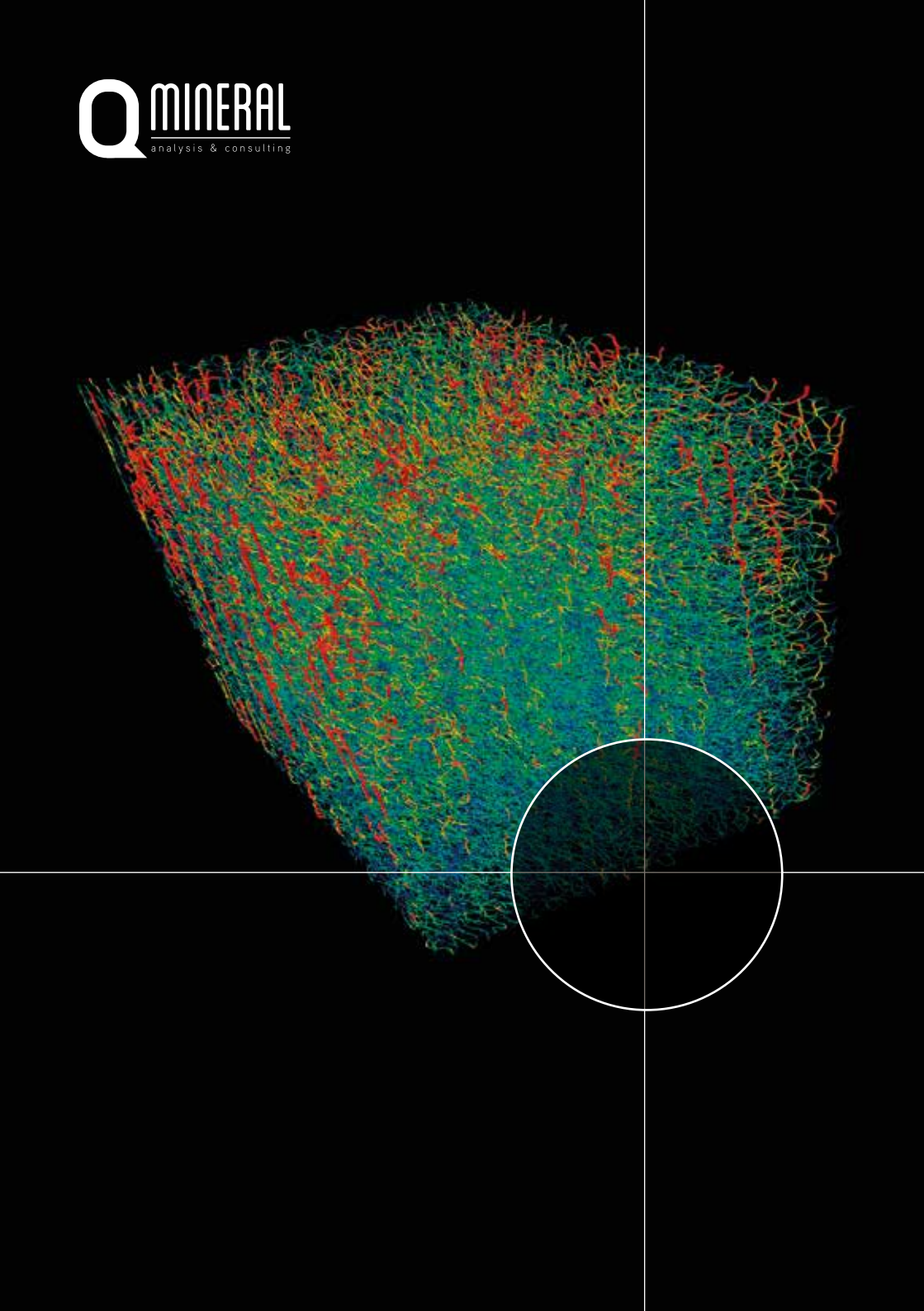

CT

Computer Tomography (CT) - Scanning: static or dynamic

In the main, the micro structure of a material determines its macroscopic properties. A typical example is porosity. Pores vary in size and shape, but also with respect to their connectivity. Because of the unique possibilities of CT-scanning, we are able to characterize the complete 3-D structure of a material on a micrometer level.
In specific cases, a 4-D visualization of the material may be instructive, the 4th dimension being a variable as time, temperature, relative humidity, pressure or extension.

Analysis	Required sample size	Turnaround time
Computer Tomography (CT)	On request	1 week

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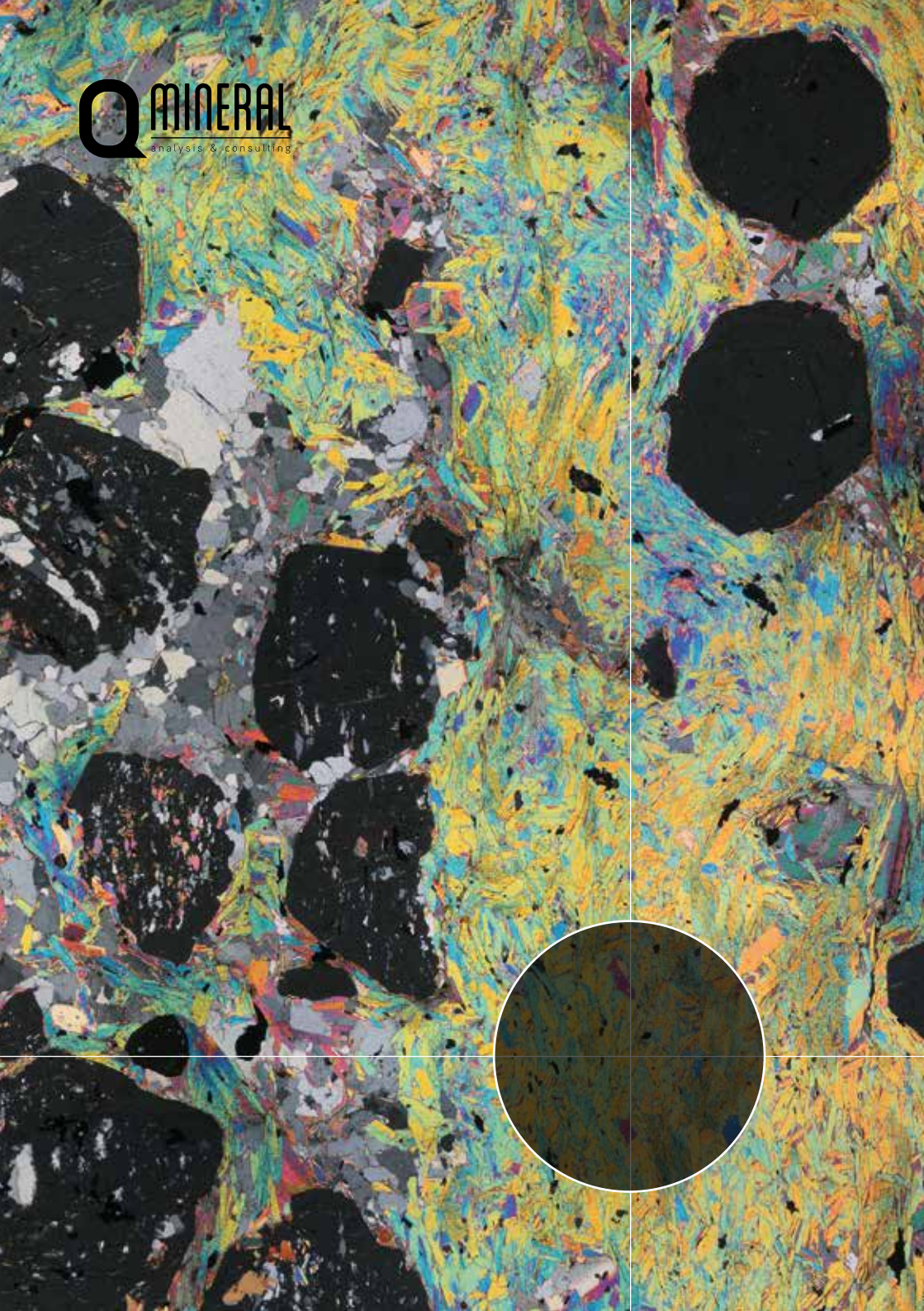
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PETROGRAPHY

Thin section petrography

Thin section petrography is a key tool for the identification of rock types, depositional environments, sedimentological or (micro-)tectonic textures and diagenetic processes. It also allows to discern pore types and their interconnectivity. At Qmineral, thin sections are prepared by vacuum impregnation and water-free polishing to avoid the risk of artifacts. The fluorescent impregnation resin that we use, allows visualization of pores and organic matter. Polarisation microscopy is used for qualitative description of pores and particles. Image Analysis (IA) allows us to quantify pore or particle properties such as their size and shape distribution. Point counting analysis is a very useful tool to quantify specific features which often can not be assessed from other measurements. Typical examples are types of porosity, phases of cementation, microfossil abundances and intra- or extraclast types.

Analysis	Required sample size	Turnaround time*
Thin section petrography	Sample with a section of at least 3cm x 2cm	2 weeks

(*) rush analysis possible on demand

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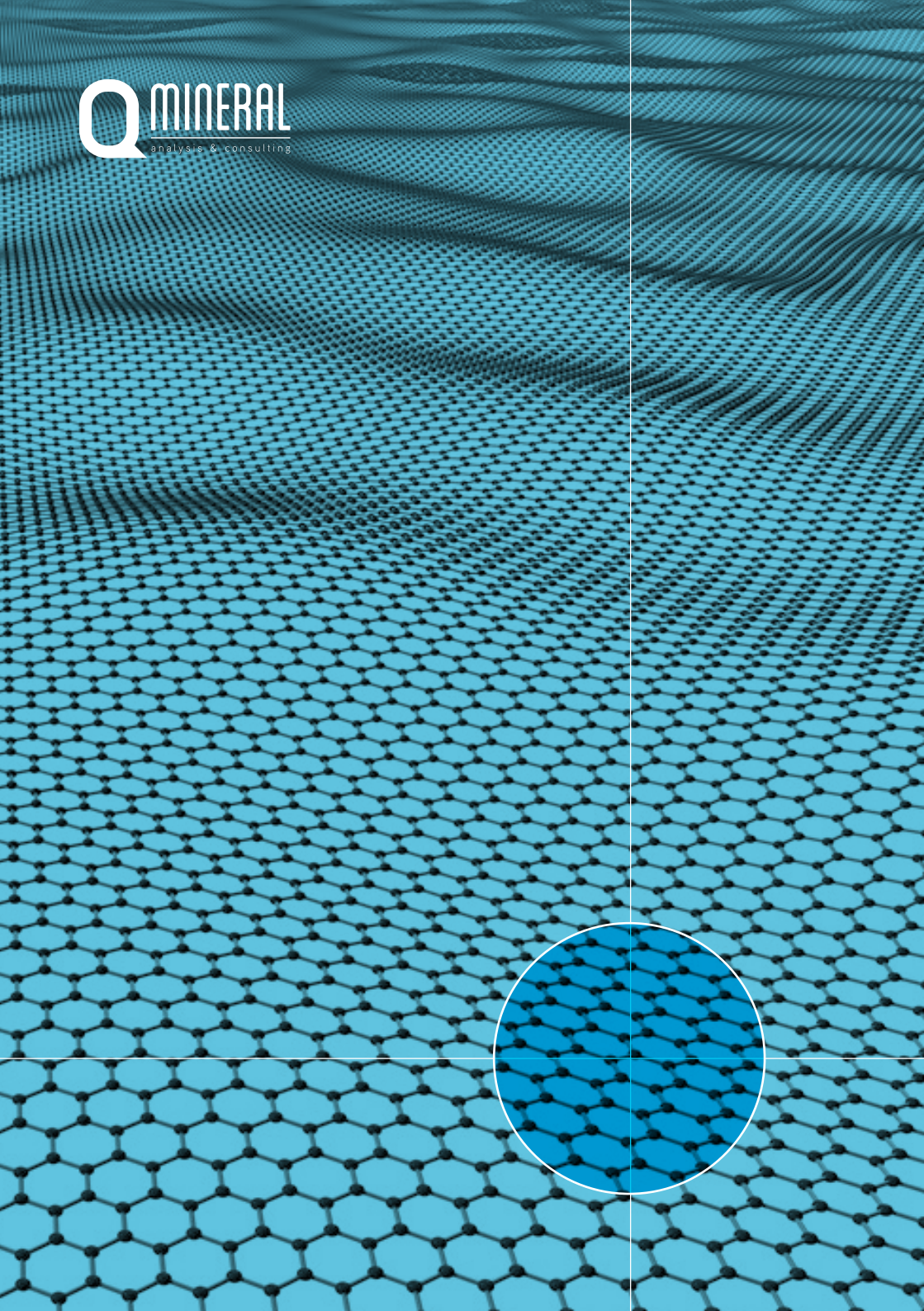
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SSA

Specific Surface Area (SSA) and Pore Size Distribution

Physisorption

The BET or Langmuir surface area of a material is determined from the measurement of N_2-gas adsorption at different partial pressures (ISO 9277). Also, the Pore Size Distribution of a material may be assessed from the adsorption of N_2-gas. We use a 100-point adsorption/desorption isotherm to quantify pores from 7Å to 0.35µm. Such an analysis allows to quantify small pores which are inaccessible by most other methods such as Hg-intrusion (MICP) or (electron-)microscopy.

Analysis	Required sample size	Turnaround time*
Specific Surface Area (SSA) by gas adsorption (BET)	1 gram	1 week
Specific Surface Area (SSA) and Pore Size Distribution (20Å to 0.3µm) by gas adsorption	1 gram	1.5 week
Specific Surface Area (SSA) and Pore Size Distribution (4Å to 0.3µm) by gas adsorption	1 gram	1.5 week

(*) rush analysis possible on demand

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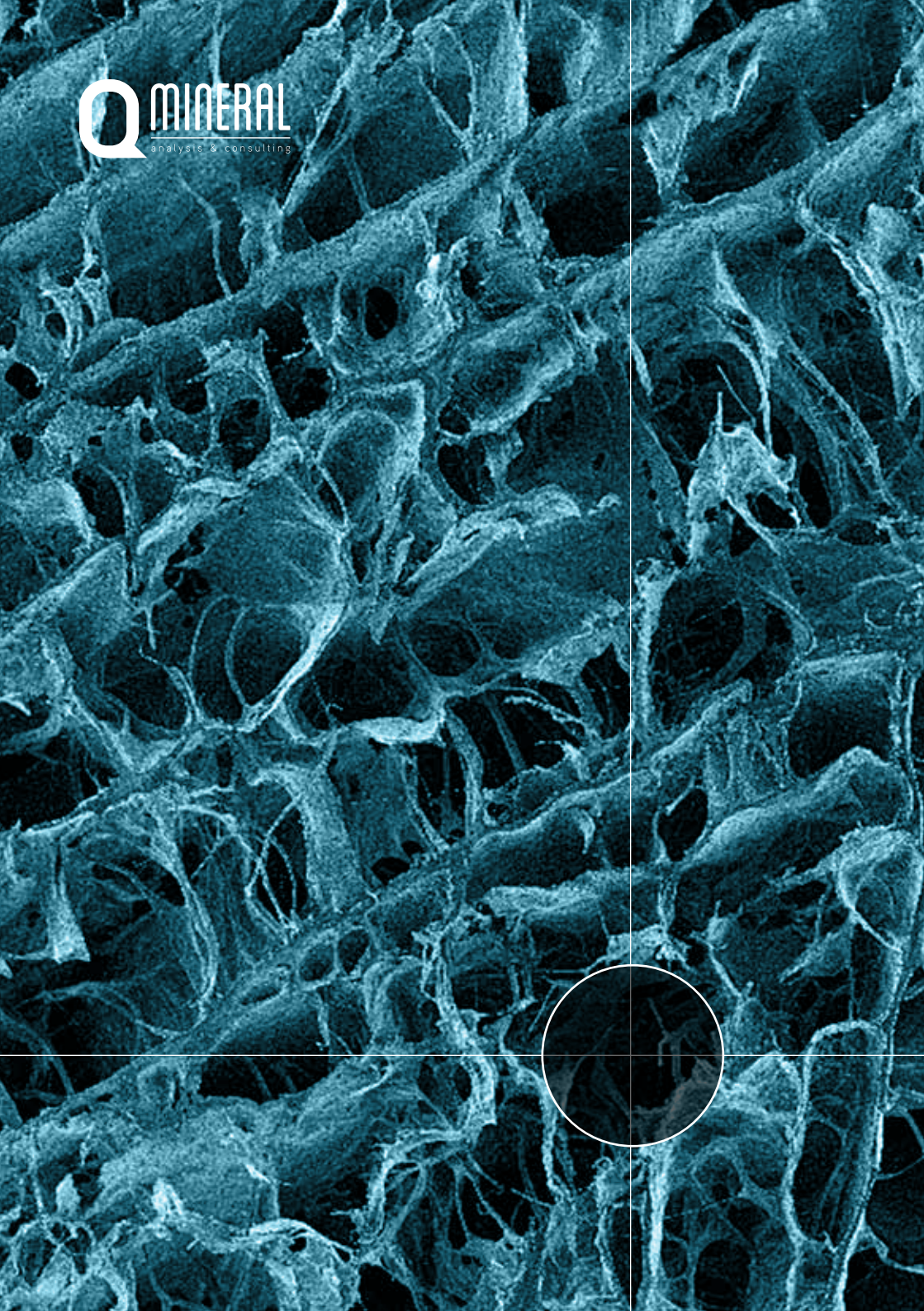
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POROSITY/GRAIN DENSITY

Porosity/Grain density

Grain densities can be assessed by either accurate mineralogical analyses or by He-pycnometry (ASTM D5550-14).

If mineralogy is used for the calculation, the mineral concentrations are multiplied with their respective densities, which are accurately determined from Rietveld refinements (see for instance Bush et al. 2017).

In the case, He-pycnometry is chosen, the total porosity can be readily calculated, if samples of known sizes are used.

As porosity may change significantly under confinement, Qmineral also measures its stress dependency. Typically He-pycnometry is done at 4 different confining pressures (up to 30MPa).

Busch, A., Schweinar, K., Kampman, N., Coorn, A., Pipich, V., Feoktystov, A., Leu, L., Amann-Hildenbrand, A. and Bertier, P. (2017). Determining the porosity of mudrocks using methodological pluralism, Geological Society, London, Special Publications, 454.

Analysis	Required sample size	Turnaround time*
Porosity by He-Pycnometry	Rock sample of at least 1cm x 1cm x 1cm (0.4 inch x 0.4 inch x 0.4 inch)	1 week

(*) rush analysis possible on demand

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PARTICLE SIZE ANALYSIS

Particle Size Analysis

Laser diffraction is used to determine the particle size distribution of materials ranging from submicron- to millimeter size (ISO 13320)

Samples are dispersed in a suitable suspension fluid (including additives or dispersants if required) and pumped through a laser beam. From the image generated by the particle/laser interaction, its size is deduced. Many particles are analyzed to obtain a statistically significant particle size distribution.

Qmineral can also determine particle size distributions by the use of a Sedigraph (Micromeritics), sieving or image analysis.

Analysis	Required sample size	Turnaround time**
Particle Size Analysis by Laser Diffraction	Clay rich samples: 0.5 grams Clay poor samples: 3 grams	2 days
Particle Size Analysis with SediGrap	5 grams	2 days

(*) rush analysis possible on demand

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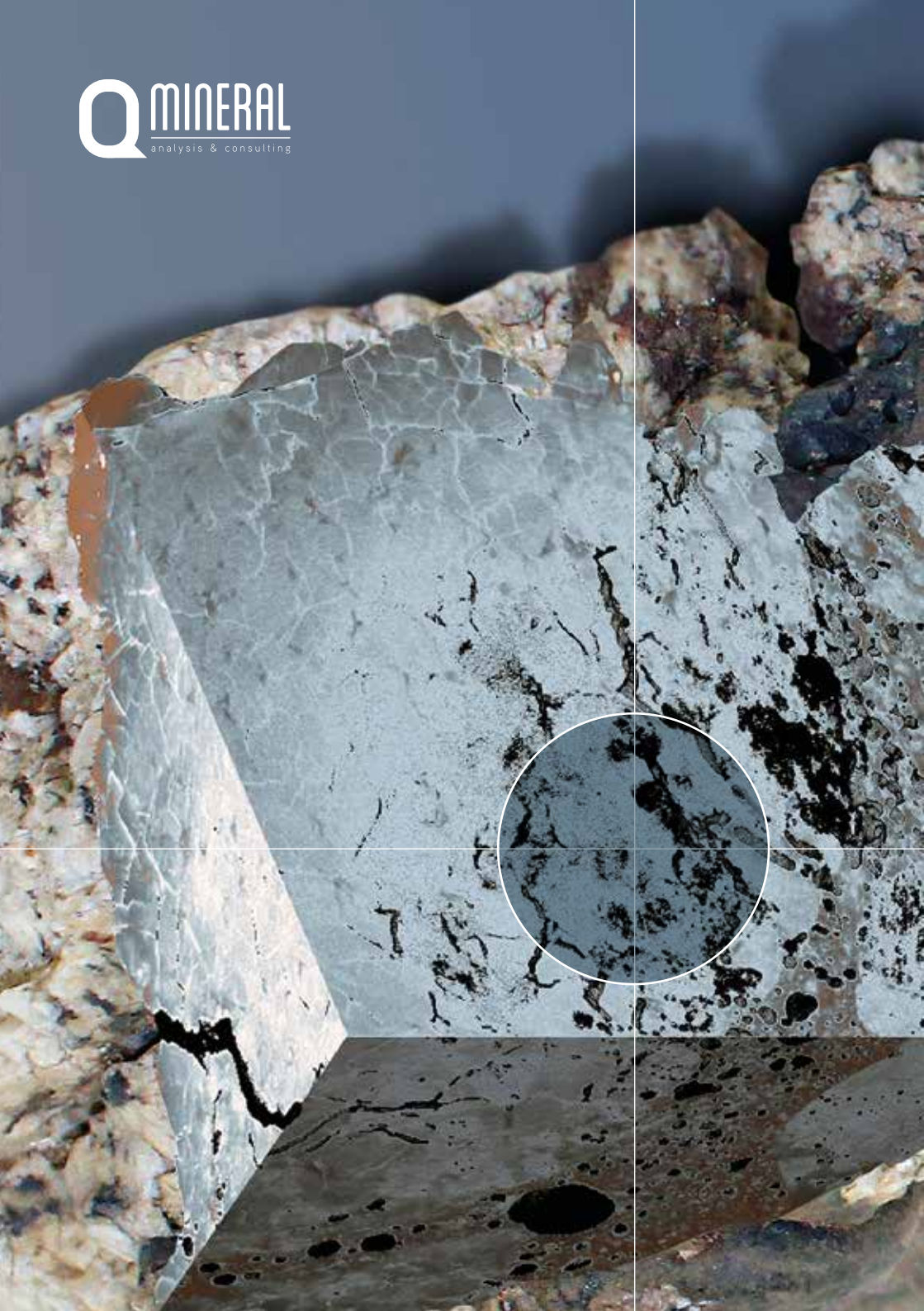
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SEM

Scanning Electron Microscopy (SEM)

- Scanning Electron Microscopy (SEM)

Scanning Electron Microscopy makes it possible to unravel the identity of trace minerals, the micro-composition of phases, the nature of the micropore systems and the origin of clays.

The morphology of the mineral phases and their spatial relationship (particularly of clays) is readily visible by SEM, as well as the spatial pore geometry and flow paths.

The X-ray energy dispersive spectrometer (EDX-detector) provides chemical and elemental analysis at any location of interest in the sample, on volumes of only a few cubic micrometers.

Specific issues that can be resolved with SEM-EDX (usually in combination with XRD) are:

- evaluation of formation damage
- location of damaging clays, zeolites or other mineral phases
- identification of the nature of any process-induced scales, depositions, sludges, etc. (i.e. non natural samples)

- Focussed/Broad Ion Beam – Scanning Electron Microscopy (FIB/BIB-SEM)

Where SEM gives a 2-D view of your sample, FIB/BIB-SEM allows to generate a 3-D view of any zone of interest. By ion-milling the sample, the exposed area can be analyzed, layer by layer. It is the ideal tool for the 3D-visualisation of the pore network. It is therefore generally used in the study of unconventional rock types. Moreover, it allows to:

- Determine the pore size distribution
- Visualize pore connectivity
- Identify the best lithotypes for fracture simulation

Analysis	Required sample size	Turnaround time*
Scanning Electron Microscopy	On request	1 week

(*) rush analysis possible on demand

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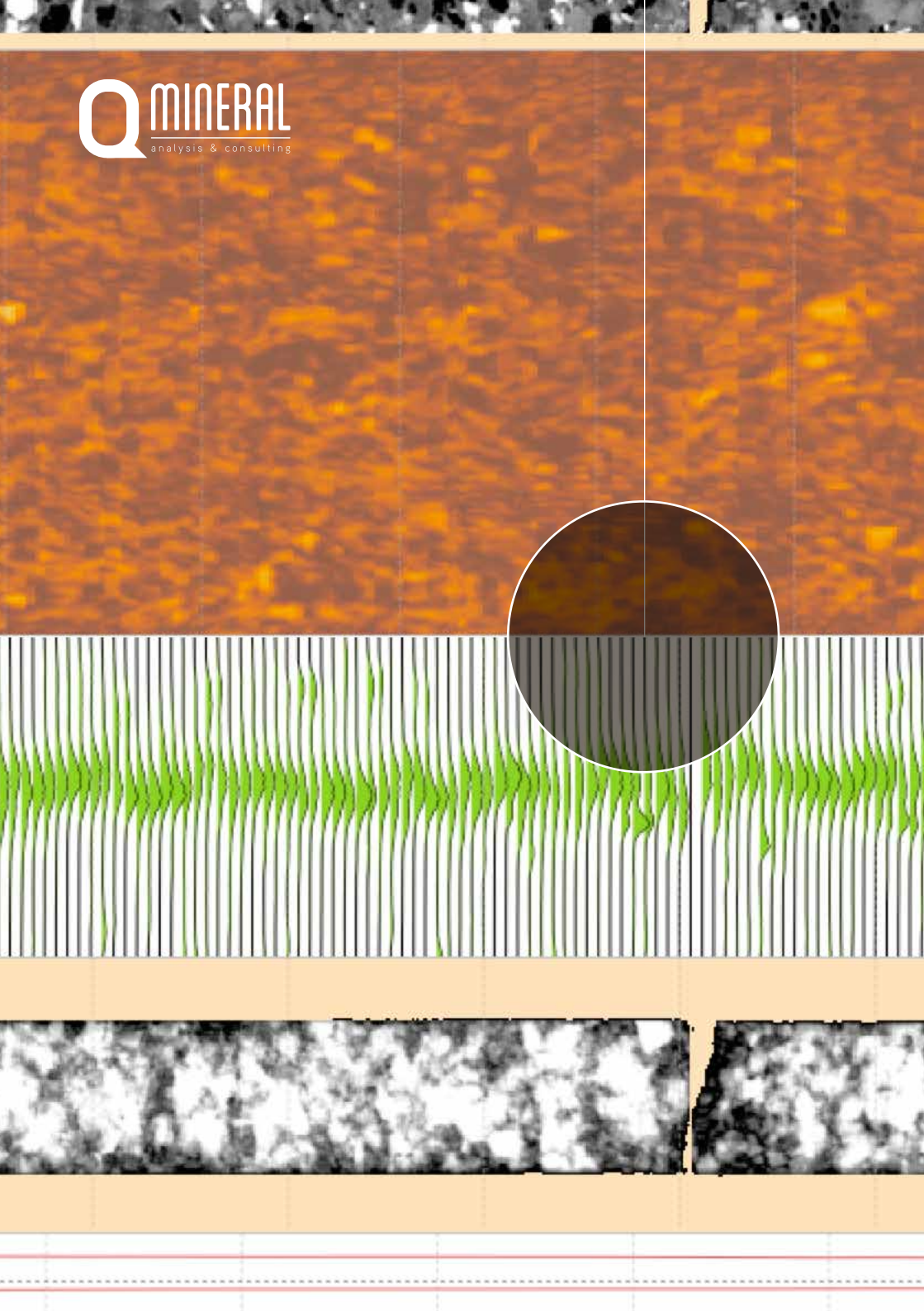
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DATA INTEGRATION

optimizing algorithms

For suites of analysis performed on a range of samples, the data can be combined to obtain a consistent, integrated, mineralogical-geochemical evaluation of the formation. It includes an (A) optimization of the bulk elemental composition of the sample with the quantitative phase analysis results, to obtain an individual mineral chemical composition, (B) a distribution of minor and trace elements into minerals, and (C) a calculation of fundamental wireline log petrophysical parameters of individual minerals in an oil reservoir which can be used in a wireline log mineral modeling program.

Analysis	Required sample size	Turnaround time*
Data Integration	On request	On request

(*) rush analysis possible on demand

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REQUEST FOR ANALYSIS

Qmineral Analysis and Consulting

Carrier:_____ | Waybill #:_____ | # of Packages:_____ | # of Samples:_____

FOR OFFICE USE ONLY Date Received: | Batch ID:

Priority: ☐ Normal (may vary depending on package and time of year - please enquire)

☐ RUSH (required by)_____
(Note: subject to surcharge, method dependent)

Confirmation of Sample Receipt: ☐ Yes ☐ No

By: E-mail:_____

Client Info: Client Batch #:_____

Quote #, PO #, Proforma #:_____

Shipment #:_____

Project:_____

Company:_____
Attn:_____
Address:_____

Phone:_____
E-mail:_____

Invoicing instructions:_____
Company:_____
VAT nr.:_____
Address:_____

Phone:_____
E-mail:_____

Report: ☐ Written ☐ Spreadsheet

Return		Dispose	Store
☐ After Analysis	☐ After 60 days	☐ After 60 days (€0)	☐ €0.25/sample/month

Return Samples To:
Company:_____
Address:_____

Attn:_____ Phone:_____

Method of Sample Return:
☐ At cost_____
☐ Our Carrier Account:_____
Carrier Name:_____
Account #:_____
Phone:_____

Special Instructions/Comments:_____

AUTHORIZED SIGNATURE:

FOR FASTER TURNAROUND TIME, EMAIL A COPY OF YOUR SUBMITTAL FORM TO info@qmineral.com

Client Name:

# of samples	Sample Numbers (list all or range)	Sample Type	Requested Analysis

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# of samples	Sample Numbers (list all or range)	Sample Type	Requested Analysis

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